

# MAJOR REED'S WORK IN HAVANA;

## How He Proved That Yellow Fever Is Transmitted Only By One Species Of Mosquito And That Articles Used Or Soiled By Patients Do Carry Infection.

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**Non-Immunes Slept for Days in Soiled Bedding of Yellow Fever Cases, in Sealed Room, With No Ill Effect—Afterwards Promptly Infected by Mosquito—The Subsequent Campaign in Havana—Yellow Fever Wiped Out There After 150 Years Supremacy.**

The appearance of yellow fever in New Orleans and the determination of Dr. White, head of the Federal forces sent here, of the State and City Boards of Health and of practically the whole of the medical fraternity to appeal to the whole community for co-operation in the effort to apply successfully the dogma that yellow fever is transmitted only by a certain species of mosquito has aroused intense interest in the subject of the causation of yellow fever epidemics. Some details are given here of the wonderful results of the experiments of the commission headed by Major Walter Reed of the United States Army in Cuba, results which, it is claimed, have enabled the authorities to make Havana, the home of yellow fever, practically immune after 150 years of constant fever. The whole credit of the development of the theory into a scientific fact is due to Major Reed, who, with other officers and privates of the United States Army, risked their lives in the demonstration. Assistant Surgeon Lazear lost his life in the attempt. Major Reed succumbed three years ago to an attack of appendicitis in the city of Washington.

### Major Reed a Brilliant Virginian.

Major Walter Reed was born in Gloucester county, Virginia, in 1851. He was the son of the Rev. Lemuel

Sutton Reed. He received a fair primary education and then went to the University of Virginia to study medicine, graduating in 1868, when only 17 years of age. He secured a second degree at Bellevue Medical College in New York and then served in the Brooklyn and Blackwell's Island Hospital. Before he was 21 he was a district physician in New York, and at 22 was one of the five inspectors of the Board of Health of Brooklyn. He went into the United States Army as Assistant Surgeon with the rank of First Lieutenant in 1875, and during the next eighteen years served in Arizona, Nebraska, Dakota and in the Southern and Eastern States. He was always an indefatigable student and a pioneer. In 1890 he went to Baltimore, working in the laboratories of Johns Hopkins University. In 1893 he was made surgeon with the rank of Major and was detailed in Washington as Curator of the Army Medical Museum and Professor of Bacteriology at the Army Medical School. He won high praise for his writings and became an expert in investigating the causes of epidemic diseases at military posts and in making sanitary inspections. During the Spanish-American war he was selected as the head of a board to study the causation and spread of typhoid in the camps of the volunteer troops, and the report of the commission, a monumental work, is

now in course of publication by the Government and is expected to serve as a basis for future study of the epidemiology of typhoid fever.

His great work in Cuba, in demonstrating that yellow fever is transmitted by the mosquito, is thus briefly described in a memoir published last year by the Walter Reed Memorial Association at Washington.

### Sent to Cuba to Study Yellow Fever.

"In June, 1900, Major Reed was sent to Cuba as president of a board to study the infectious diseases of the country, but more especially yellow fever. Associated with him were Acting Assistant Surgeons James Carroll, Jesse W. Lazear and A. Agramonte. At this time the American authorities in Cuba had for a year and a half endeavored to diminish the disease and mortality of the Cuban towns by general sanitary work, but while the health of the population showed distinct improvement and the mortality had greatly diminished, yellow fever apparently had been entirely unaffected by these measures. In fact, owing to the large number of non-immune foreigners, the disease was more frequent than usual in Havana and in Quemados, near the camp of American troops, and many valuable lives of American officers and soldiers had been lost.



"Reed was convinced from the first that general sanitary measures alone would not check the disease, but that its transmission was partly due to an insect.

"The fact that malarial fever, caused by an animal parasite in the blood, is transmitted from man to man through the agency of certain mosquitoes had been recently accepted by the scientific world; also, several years before, Dr. Carlos Finlay of Havana had advanced the theory that a mosquito conveyed the unknown cause of yellow fever, but did not succeed in demonstrating the truth of his theory.

"Dr. H. R. Carter of the Marine Hospital Service had written a paper showing that although the period of incubation was only five days, yet a house to which a patient was carried did not become infected for from fifteen to twenty days.

"To Reed's mind this indicated that the unknown infective agent has to undergo a period of incubation of from ten to fifteen days and probably in the body of the biting insect.

#### Sanarelli Theory Disproved.

"Up to this time the most generally accepted theory as to the causation of yellow fever was that of Sanarelli, who claimed that the bacillus iceteroids discovered by him was the specific agent of the disease. Major Reed, in association with Dr. Carroll, had, however, already demonstrated that this bacillus was one widely disseminated in the United States, and bore no such relation to yellow fever.

"In June, July and August, 1900, the commission gave their entire attention to the bacteriological study of the blood of yellow fever patients and the postmortem examination of the organs of those dying of the disease. In twenty-four cases where the blood was repeatedly examined, as well as in eleven carefully studied autopsies, bacillus iceteroids were not discovered, nor was there any indication of the presence in the blood of a specific cause of the disease.

"Application was made to General Leonard Wood, the military governor of Cuba, for permission to conduct experiments on non-immune persons, and a liberal sum of money requested for the purpose of rewarding volunteers who would submit themselves to experiment.

"It was indeed fortunate that the military governor of Cuba was a man who, by his breadth of mind and special scientific training, could readily appreciate the arguments of Major Reed as to the value of the proposed work.

"Money and full authority to proceed were promptly granted, and to the everlasting glory of the American soldier, volunteers from the army offered themselves for experiment in plenty, and with the utmost fearlessness.

#### Dr. Lazear Dies a Hero.

"Before the arrangements were en-

tirely completed Dr. Carroll, a member of the commission, allowed himself to be bitten by a mosquito that twelve days previously had filled itself with the blood of a yellow fever patient. He suffered from a very severe attack, and his was the first experimental case. Dr. Lazear also experimented on himself at the same time, but was not infected. Some days later, while in the yellow fever ward, he was bitten by a mosquito and noted the fact carefully. He acquired the disease in its most terrible form and died a martyr to science and a true hero.

"No other fatality occurred among the brave men who in the course of the experiments willingly exposed themselves to the infection of the dreaded disease.

"A camp was especially constructed for the experiments, about four miles from Havana, christened Camp Lazear in honor of the dead comrade. The inmates of the camp were put into most rigid quarantine and ample time was allowed to eliminate any possibility of the disease being brought in from Havana.

"The personnel consisted of three nurses and nine non-immunes, all in the military service, and included two physicians.

"From time to time Spanish immigrants, newly arrived, were brought in from the immigrant station; a person not known to be immune was not allowed to leave camp, or if he did was forbidden to return.

"The most complete record was kept of the health of every man to be experimented upon, thus eliminating the possibility of any other disease than yellow fever complicating the case.

#### The Wonderful Experiments.

"The mosquitoes used were especially bred from the eggs and kept in a building screened by wire netting. When an insect was wanted for an experiment it was taken into a yellow fever hospital and allowed to fill itself with the blood of a patient; afterward, at varying intervals from the time of this meal of blood it was purposely applied to non-immunes in camp.

"In December five cases of the disease were developed as the result of such applications, in January three and in February two, making in all ten, exclusive of the cases of Drs. Carroll and Lazear. Immediately upon the appearance of the first recognized symptoms of the disease, in any one of these experimental cases, the patient was taken from Camp Lazear to a yellow fever hospital, one mile distant. Every person in camp was rigidly protected from accidental mosquito bites, and not in a single instance did yellow fever develop in the camp except at the will of the experimenters. The experiments were conducted at a season when there was the least chance of naturally acquiring the disease and the mosquitoes used were kept active by maintaining them at a summer temperature.

"A completely mosquito-proof build-

ing was divided into two compartments by a wire screen partition; infected insects were liberated on one side only. A brave non-immune entered and remained long enough to allow himself to be bitten several times. He was attacked by yellow fever, while two susceptible men in the other compartment did not acquire the disease, although sleeping there thirteen nights. This demonstrates in the simplest and most certain manner that the infectiousness of the building was due only to the presence of the insects.

"Every attempt was made to infect individuals by means of bedding, clothes, and other articles that had been used and soiled by patients suffering with virulent yellow fever."

#### Dr. Carroll's Convincing Report.

"Naturally yellow fever is transmitted by the mosquito, and always and only by the mosquito. The harmlessness of fomites has been fully demonstrated by our experiments in 1900 and 1901, in which three young Americans slept for twenty consecutive nights in a room from which mosquitoes were excluded garnished with articles soiled with discharges from fatal and other cases of yellow fever. Three and four large boxes were packed and unpacked each morning by these non-immunes, who suffered no disturbance of health from these exposures. The room was twenty feet by fourteen feet, double-walled, tightly sealed, heated to above 90 degrees Fahrenheit and dark.

"Two other non-immunes then occupied the room for twenty nights, while additional articles of bedding and clothing were added. They slept in the garments and between the sheets that had covered cases of yellow fever, some of which were fatal. The result of the second attempt was nil. A third attempt was then made with two additional non-immunes, equally without success. Not the slightest indisposition followed close and intimate contact with this repulsive material in any case. Temperatures and pulse rates were recorded at regular and frequent intervals. Four of these seven non-immunes were subsequently infected by blood-injections and by means of infected mosquitoes."

Another kind of experiment was included in the Cuban investigations of yellow fever. A room was prepared so as to preclude the possibility of infection by fomites (infected articles). Every article contained in the room had been previously disinfected and was thoroughly clean. The only possible means of infection with yellow fever was by infected mosquitoes, liberated in the room containing the human subjects of the experiment. Yellow fever promptly followed the introduction of mosquitoes into the room.

The Reed memoir continues:

#### What Experiments Proved.

"Besides the experimental cases caused by mosquito bites, four non-immunes were infected by injecting blood



drawn directly from the veins of yellow fever patients in the first two days of the disease, thus demonstrating the presence of an infectious agent in the blood at this early period of the attack.

"Even the blood serum of a patient, passed through a bacteria-proof filter, was found to be capable of causing yellow fever in another person.

"The details of the experiments are most interesting, but it must here suffice to briefly sum up the principal conclusions of this admirable board of investigators of which Reed was the master mind:

"1. The specific agent in the causation of yellow fever exists in the blood of a patient for the first three days of his attack, after which time he ceases to be a menace to the health of others.

"2. A mosquito of a single species, *stegomyia facia*, ingesting the blood of the patient during this infective period is powerless to convey the disease to another person by its bite until about twelve days have elapsed, but can do so thereafter for an indefinite period, probably during the remainder of its life.

"3. The disease cannot be spread in any other way than by the bite of the previously infected *stegomyia*. Articles used or soiled by patients do not carry infection.

"These conclusions pointed so clearly to the practical method of exterminating the disease that they were at once accepted by the sanitary authorities in Cuba and put to the test in Ha-

vana, where for nearly a century and a half, by actual record, the disease had never failed to appear annually.

#### Fever Leaves Havana After 150 Years.

"In February, 1901, the chief sanitary officer in Havana, Major W. C. Gorgas, Medical Department of the United States army, instituted measures to eradicate the disease, based entirely on the conclusions of the commission. Cases of yellow fever were required to be reported as promptly as possible, the patient was at first rigidly isolated, and immediately upon the report a force of men from the sanitary department visited the house. All the rooms of the building and of the neighboring houses were sealed and fumigated to destroy the mosquitoes present. Window and door screens were put up and after the death or recovery of the patient his room was fumigated and every mosquito destroyed. A war of extermination was also waged against mosquitoes in general, and an energetic effort made to diminish the number bred by draining standing water, screening tanks and vessels, using petroleum on water that could not be drained, and in the most systematic manner destroying the breeding places of the insect.

"When the warm season returned a few cases occurred, but by September, 1901, the last case of yellow fever originated in Havana, since which time the city has been entirely exempt from the terrible disease that had there kept

strong hold for a hundred and fifty years. Cases are now admitted into Havana from Mexican ports, but are treated under screens with perfect immunity in the ordinary city hospitals. The crusade against the insects also caused a very large decrease in malarial fevers.

More recent investigations into the cause and spread of yellow fever have only succeeded in verifying the work of Reed and his commission in every particular and adding very little to our knowledge of the disease.

"Later researches by Guiteras in Havana, by the Public Health and Marine Hospital Service in Vera Cruz, and lastly by the delegation from the Pasteur Institute of Paris in Rio de Janeiro, all confirm in the most convincing manner both the accuracy and comprehensiveness of the conclusions of the American commission. It has been well said that Reed's experiments will always remain as models in the annals of scientific research, both for the exactness with which they were adapted to the points to be proved and the precautions taken that no experiment should be vitiated by failure to exclude all possible sources of error.

"Appreciation of Reed's work was instant in the scientific world. Honorary degrees from Harvard University and the University of Michigan were conferred upon him, learned societies and distinguished men delighted to honor him, and after his death Congress voted a special pension to his widow."

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